Electronic Supplementary Material (ESI) for Physical Chemistry Chemical Physics

Supplementary Material for:

Correlation between electron localization and metal ion mutagenicity in DNA synthesis from QM/MM calculations

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I. STRUCTURAL RESULTS

Table S1: Coordination distances (Å) for the catalytic and nucleotide binding metals. [a]dU refers to the incoming nucleotide.

	Mg^{2+}	Na^{+}	Ca^{2+}	Zn^{2+}	Co^{2+}	Cr^{2+}	Cu^{2+}	Mn^{2+}	Ni^{2+}
	Catalytic Metal (Me1)								
OD1–D427	2.0	2.2	2.3	2.0	2.0	2.0	2.0	2.1	2.0
OD1–D429	2.1	2.3	2.4	2.1	2.1	2.3	2.2	2.2	2.0
OD2–D490	2.0	2.3	2.2	1.9	1.9	2.0	1.9	2.0	2.0
O3′	2.2	2.6	2.5	2.4	2.3	2.2	2.2	2.4	2.3
O2A–dU[a]	2.2	2.3	2.4	2.3	2.3	2.2	2.1	2.3	2.2
O–H_2O	2.2	2.8	2.5	2.1	2.2	2.5	2.3	2.3	2.2
	Nucleotide Binding Metal (Me2)								
OD2–D427	2.0	2.2	2.3	2.0	2.0	2.0	2.0	2.1	2.0
OD2–D429	2.0	2.3	2.3	2.0	2.0	2.0	2.0	2.1	2.0
O3G–dU[a]	2.1	2.3	2.3	2.1	2.1	2.1	2.1	2.2	2.1
O2B–dU[a]	2.1	2.5	2.5	2.2	2.2	2.1	2.1	2.3	2.2
O2A–dU[a]	2.0	2.2	2.3	2.0	2.0	2.3	2.1	2.1	2.0
O–H_2O	2.1	2.5	2.4	2.2	2.2	2.6	2.6	2.3	2.2

Table S2: Nucleophylic attack and inter–metal distances (Å) for the optimized structures.

	Mg^{2+}	Na^{+}	Ca^{2+}	Zn^{2+}	Co^{2+}	Cr^{2+}	Cu^{2+}	Mn^{2+}	Ni^{2+}
O3'–Pα	3.30	3.59	3.61	3.35	3.40	3.41	3.28	3.46	3.36
Me1–Me2	3.56	3.53	3.73	3.58	3.58	3.74	3.58	3.66	3.51

II. TS OPTIMIZATIONS

Figure S1 shows a scheme for the reaction mechanism of Polλ . Figure St shows the superposed optimized structures for the re–optimized transition states with Mg^{2+} and Mn^{2+}.

Figure S1: Schematic of the reaction mechanism for nucleotide incorporation in Polλ.

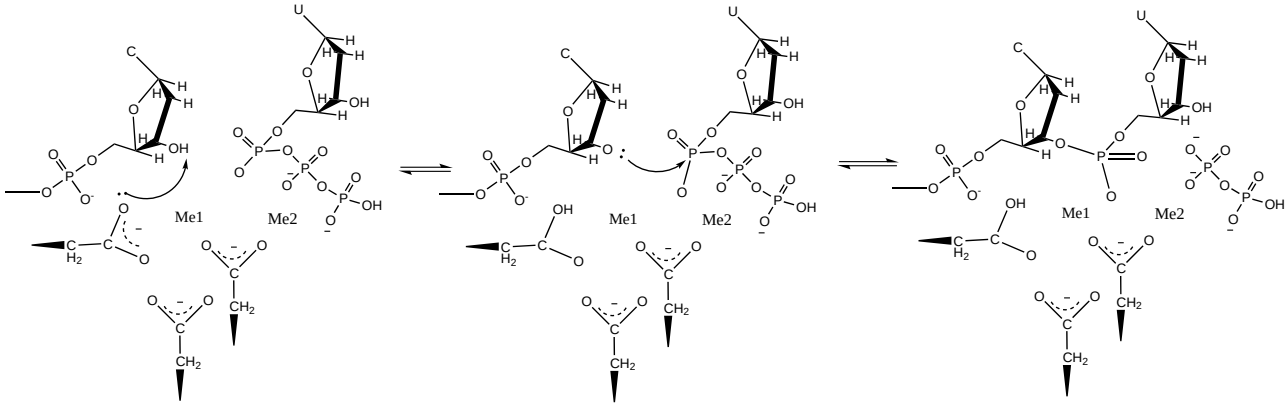
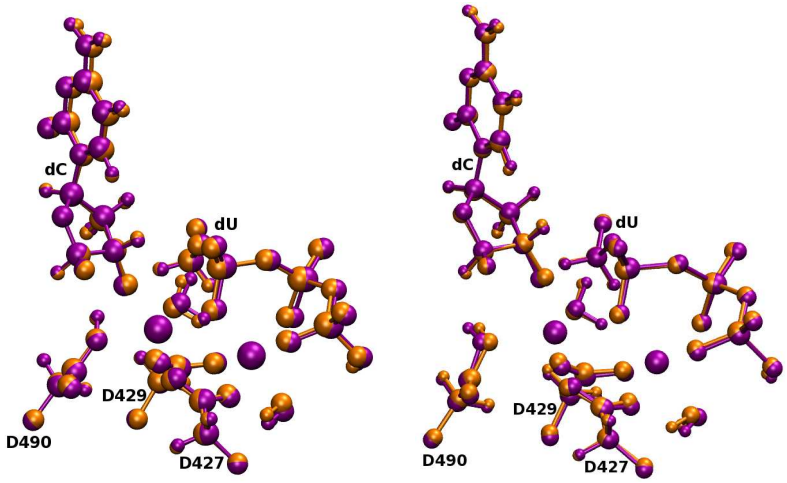


Figure S2: Optimized active sites for Mg^{2+} (orange) and Mn^{2+}(purple). Left: TS1, right: TS2



III. ELF ANALYSIS

Figure S2 shows the ELF topological analysis for Na^{+}, Ca^{2+} at isovalue=0.8. Figure S3 shows the location of the centroids of the basins for Polλ with Na^{+}, Ca^{2+}, Co^{2+}, Cr^{2+}, Cu^{2+}, Mn^{2+}, Ni^{2+} and Zn^{2+}. The orientation is the same as for Fig. 1 in the main text. Figures S4 through S12 show the results for the ELF analysis of each cation sepparately at medium and high isovalues. The high isovalues are chosen to show the shell structure of the cations and the splitting (or lack thereof) of the sub–valence. In this case, ELF calculations were performed for each cation separately with grids of 300^3. Figure S4 (left) includes the QM subsystem to show the orientation of the cations within the active site. Figure S13 shows the ELF analysis for three active site model systems. The Mg^{2+} and Zn^{2+}clusters correspond to the RVS calculations (see main text). Figs. S15 and S16 show the ELF analysis for the re–optimized TS structures.

Figure S3: ELF topological analysis for Na^{+}, Ca^{2+}at isovalue 0.8

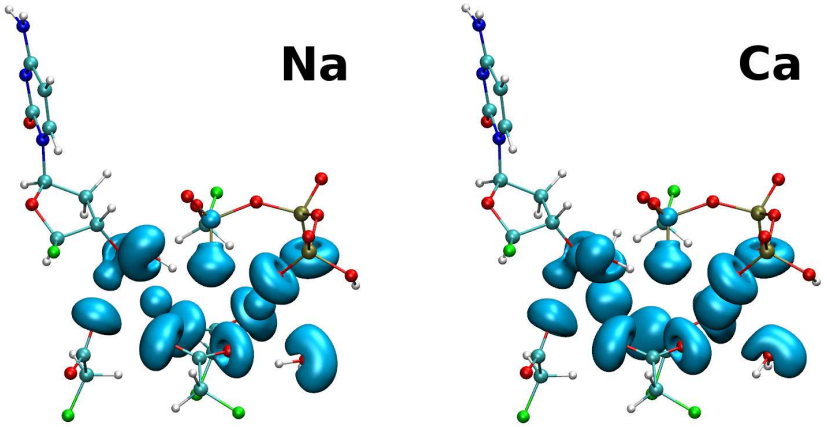


Figure S4: ELF basin centroid positions for (left to right and top to bottom) Na^{+}, Ca^{2+}, Zn^{2+}, Co^{2+}, Cr^{2+}, Cu^{2+}, Mn^{2+} and Ni^{2+}.

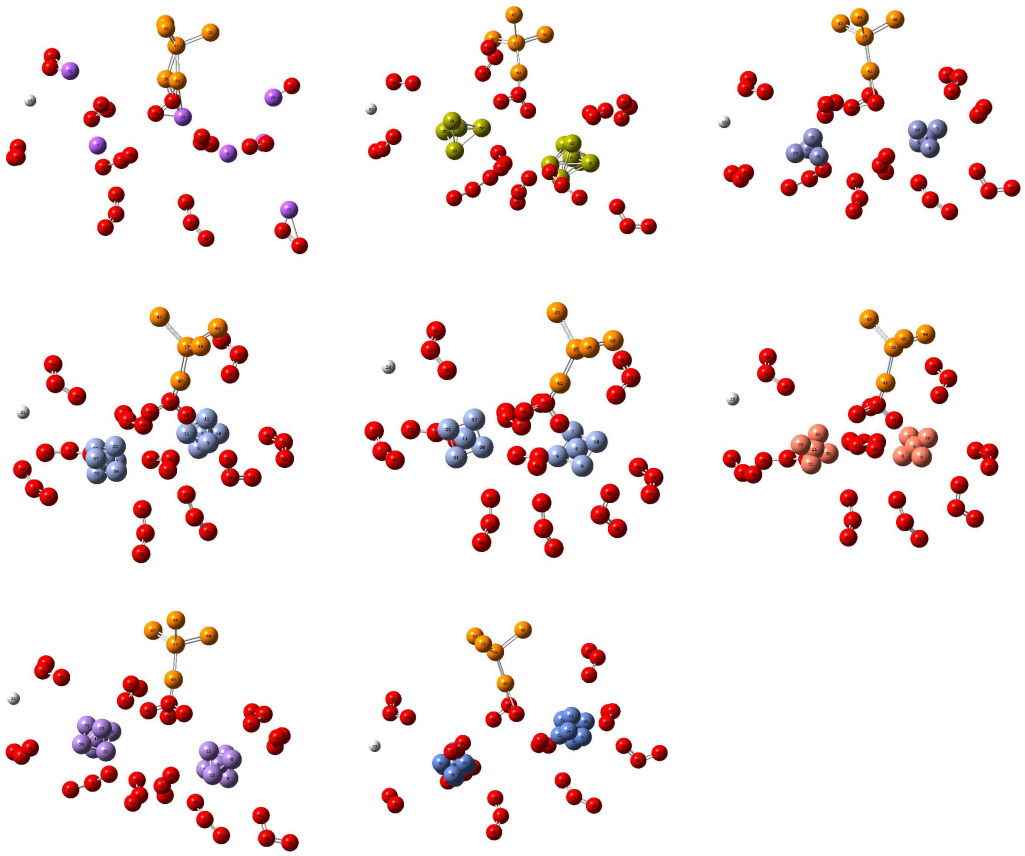


Figure S5: ELF analysis of each Mg^{2+} sepparately at isovalues of 0.5 (left) and 0.87 (right). The left figure includes the full QM subsystem to display the orientation of the cations.

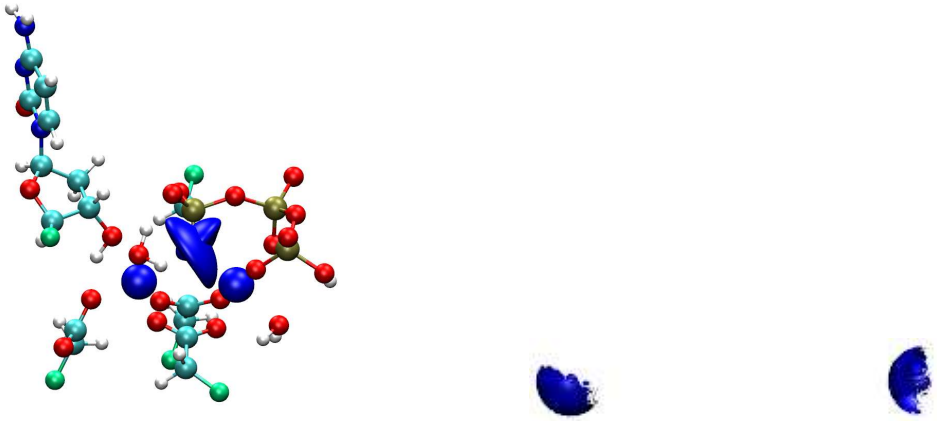


Figure S6: ELF analysis of each Na^{+} sepparately at isovalues of 0.5 (left) and 0.866 (right).

Figure S7: ELF analysis of each Ca^{2+} sepparately at isovalues of 0.5 (left) and 0.888 (right).

Figure S8: ELF analysis of each Zn^{2+} sepparately at isovalues of 0.5 (left) and 0.773 (right).

Figure S9: ELF analysis of each Co^{2+} sepparately at isovalues of 0.5 (left) and 0.75 (right).

Figure S10: ELF analysis of each Cr^{2+} sepparately at isovalues of 0.5 (left) and 0.79 (right).

Figure S11: ELF analysis of each Cu^{2+} sepparately at isovalues of 0.5 (left) and 0.78 (right).

Figure S12: ELF analysis of each Mn^{2+} sepparately at isovalues of 0.5 (left) and 0.73 (right).

Figure S13: ELF analysis of each Ni^{2+} sepparately at isovalues of 0.5 (left) and 0.75 (right).

Figure S14: ELF analysis for model complexes with Mg^{2+}(left), Zn^{2+} (middle) and Mn^{2+} (right). Isosurface values match those of figure 3 in the main text for the corresponding cations.

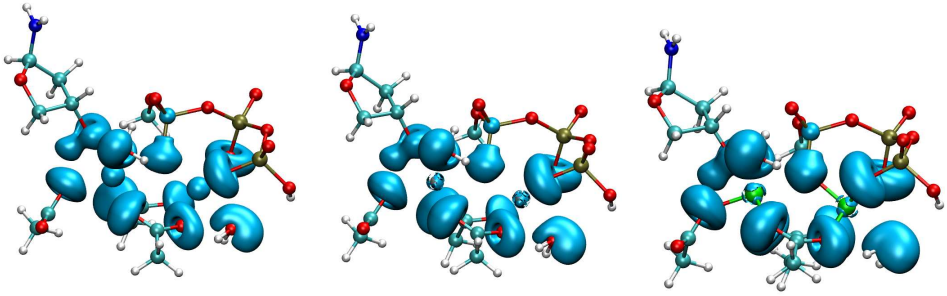


Figure S15: ELF topological analysis for the optimized TS1 (left) and TS2 (right) with Mg^{2+} in the active site.

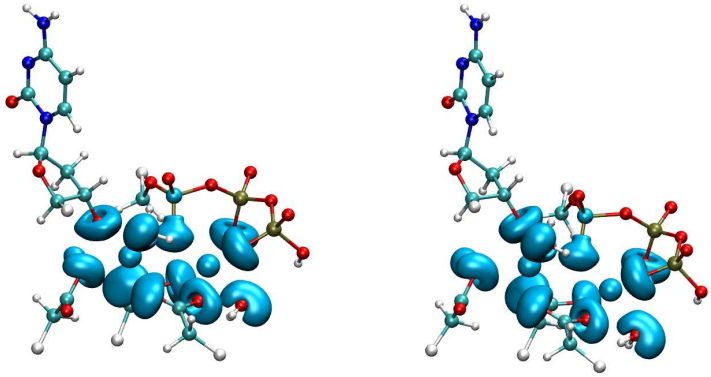


Figure S16: ELF topological analysis for the optimized TS1 (left) and TS2 (right) with Mn^{2+} in the active site.